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PEDIATRIC ASTHMA EXACERBATIONS SEEN IN THE EMERGENCY

DEPARTMENT: A DESCRIPTIVE STUDY OF

FACTORS THAT INFLUENCE HOSPITALIZATION AS AN OUTCOME

By

Debora Janet Marston

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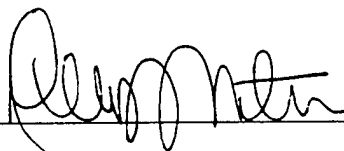
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Finally, to my daughter Kiele, who made the challenging moments of this project so much easier, I thank you for the love and joy you brought to me each and every day.

DEDICATION

This thesis is dedicated to the men and women and their families of the United States Department of Defense, for it is the United Sates Air Force that gave me this awesome opportunity to receive an advanced education while on active duty status. This thesis is also dedicated to all asthmatic children. It is my sincerest hope that the results in this study will benefit and improve the medical care of the pediatric asthma population.

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ABSTRACT

To determine predictors of hospitalization as an outcome for pediatric patients

experiencing a severe asthma exacerbation seen in the Emergency Department (ED),

specific to Department of Defense (DoD) beneficiaries, a secondary data analysis was

conducted on DoD data. Verran's (1997) theory-driven framework was used to guide the

selection of variables and analysis. The study controlled for asthma severity and

structure. Using variables identified through a literature review, a group of subjects with

hospitalization as an outcome ($n = 74$) was compared to a group of subjects without

hospitalization as an outcome ($n = 158$) by means of analysis of differences procedures.

Logistic regression was conducted using the variables found to be statistically significant.

Subjects with a history of intubation (OR = .066), having been admitted for

asthma within 1 year (OR = .307), corticosteroid administered intravenously or

intramuscularly (OR = .238) and the number of $beta_2$-agonists administered (OR = 1.832)

were the statistically significant variables.

CHAPTER ONE

INTRODUCTION

Asthma affects an estimated 14 to 15 million people in the United States, of which an estimated 4.8 million are children (Adams & Marano, 1995; Centers for Disease Control and Prevention, 1995). Asthma is the most common chronic disease of children, which, if managed properly, should rarely lead to hospitalization. Yet, acute asthma is the most common medical emergency in children and is responsible for increasing hospitalization and death rates. Acute asthma results in approximately 1.5 million emergency department visits, more than 470,000 hospital admissions, and 5,000 deaths annually (Camargo & Richardson, 1999; Centers for Disease Control and Prevention, 1996). Among children under 15, the Department of Defense's (DoD's) Emergency Department (ED) discharge rate for pediatric asthma was 340 per 100,000 cases in fiscal year 1996, as compared to the Healthy People 2000 benchmark discharge rate of 225 per 100,000 (DoD National Quality Management Program, 1998).

While the rates of asthma hospitalization and deaths are increasing across most age ranges, these rising rates are highest among children (Nowack, Hurd, Skobeloff, & Taggart, 1996). Despite advances in understanding the pathophysiology and the introduction of effective therapies, hospitalization rates, morbidity, and mortality continue to increase for children with asthma (Budetti, Weiss, Buist, Fowles, Luce, & Malveaux, 1993; Centers for Disease Control and Prevention, 1998).

Background

Asthma Guidelines

Asthma is a disease with great variation in both severity and etiology. This diversity leads to problems for both diagnosis and treatment (Bailey, Higgins, Richards, & Richards, 1992). In 1991, in response to these problems and as part of the effort to address the increased morbidity and mortality of asthma, the National Heart, Lung, and Blood Institute's (NHLBI's) National Asthma Education and Prevention Program (NAEPP) convened an expert panel on asthma to develop guidelines and offer strategies for the diagnosis and management of asthma. The NHLBI guidelines detailed four components of asthma management: use of objective measures of lung function, comprehensive pharmacological therapy for acute asthma exacerbations and long-term management, environmental control, and patient education (NAEPP, 1991). In November 1997, the NHLBI updated its guidelines and released a second version, the Expert Panel Report 2 (NAEPP, 1997). The NHLBI guidelines provide recommendations for acute asthma care emphasizing the use of objective measurements of pulmonary function to assess asthma severity and guide management strategies, aggressive inhaled $beta_2$-agonist therapy, early systemic corticosteroid administration, and early disposition decision (Emond, Camargo, & Nowak, 1998a).

The NHLBI guidelines were developed to serve as a comprehensive, consensus-based, evidence-based clinical practice guide to lead or direct a course of action. The guidelines should not necessarily be considered as absolute in the diagnosis and

management of asthma, but rather as a reference that can be tailored to the specific needs and circumstances of the patient (Emond, et al., 1998b; Kallstrom, 1997).

A key aspect of the NHLBI guidelines is the importance of a quick and accurate classification of asthma exacerbation severity, which is essential to provide proper treatment. In the ED, this assessment is often accomplished on the basis of patient history, physical examination findings, laboratory measurements, and response to therapy (Kerem, et al., 1990). Due to the fact that some assessment tools are not suitable for children, asthma exacerbation assessment proves extremely difficult with the pediatric population. The literature describes various asthma severity scores that are sometimes used in the assessment of asthma exacerbation severity. However, most scores have not been shown to predict outcomes reliably (Kerem, et al., 1990) or have only been used once or twice (Danielle, et al., 1994). In response to the confusion in assessing asthma severity, the NAEPP published guidelines for classification of asthma exacerbation severity. Based on the findings of a brief, focused history and physical examination, the level of asthma severity can be classified as mild, moderate, or severe (NAEPP, 1997).

Studies have identified roadblocks in the acceptance of the NHLBI guidelines and the use of their recommendations (Emerman, Cydulka, & Skobeloff, 1996; Sarwar, 1996). Many health care professionals fail to 'buy into' them because of the perceived prescriptive, inflexible, 'cookbook' approach (Emond, et al., 1998a; Homer, 1997; Kallstron, 1997) or a preference for solely evidence-based recommendations (Emerman, et al., 1996; Emond, Woodruff, Singh, & Camargo, 1999). Limited access to or lack of

knowledge of the Guidelines also proves to be a hindrance (Emerman, et al., 1996; Sarwar, 1996).

While certain aspects of the NHLBI guidelines have been shown to be useful in primary care (Kibbe, Kaluzy, & McLaughlin, 1994), few controlled trials have demonstrated the effectiveness and safety of the recommendations or established improvement in patient outcomes and cost-effectiveness (Emond, et al., 1999). McFadden, Elsanadi, and Gilbert (1995) noted that a one-year protocol therapy trial for acute asthma decreased average emergency department length of stay by 50 minutes, intensive care admissions by 41%, 24 hour relapses by 66%, and saved nearly $400,000. Another study that implemented a local version of the NHLBI guidelines reduced ED length of stay by 58 minutes and noted a trend toward decreased inpatient admissions without increased asthma relapses (Emond, et al., 1999). Unfortunately, neither of these studies focused on pediatric asthma or differences related to exacerbation severity. Such studies are essential before widespread acceptance and adoption will occur (Emerman, et al., 1996; Emond, et al., 1999).

Although the guidelines are a step forward in asthma management, there is a critical need for more research to determine whether using the recommendations results in improved outcomes (Emerman, et al., 1996; Emond, et al., 1998a; Emond, et al., 1999). Further, no study has examined whether use of the guidelines with severe asthmatic children can improve outcomes.

Outcome Research

Outcome research is used to document the effectiveness of health care services and the results of patient care. At this time in health care, it is vitally important to evaluate how changes that are occurring affect patient care and outcomes, and understand what those changes mean. However, these changes often occur almost instantaneously without attempts to evaluate effectiveness (Verran, 1997). Today, outcome research is not only used to market decisions and constrain costs, but also as evidence for accreditation purposes and to increase our scientific knowledge for successful care delivery (Kane, 1997; Moritz, 1995).

Three important factors have led to the current emphasis on studying outcomes in the health care fields. The first factor is cost containment. The growth of managed care and the initiation of state and federal prospective-payment systems, designed to control the increase in medical services, have raised fears that these systems will have harmful effects on the quality of care. This has resulted in an increased focus on quality assurance. The second factor is competition. Health maintenance organizations (HMOs) compete vigorously for the buyer's dollar. Price alone will not maintain HMOs in the competition, as buyers are now demanding information on quality and outcomes to ultimately base their buying decisions. The third factor is research that has documented substantial differences in various medical procedures. As a result, questions have been raised about whether these differences may be due to unnecessary costs in high use areas or less than optimal care in low use areas (Epstein, 1990). Outcome research, with its

emphasis on examining and correcting processes of care, is the first step in answering these questions.

Having recognized a discrepancy between what is believed, what is known, and what is practiced, many in the health care field pushed for creating practice guidelines based on a consensus of best available information and expert opinion. Practice guidelines provide a process ensuring appropriate care and use of services which, if followed, will positively influence outcomes. In the development of these guidelines, it became evident that the health care industry did not have a strong empirical base underlying many health care practices (Kane, 1997). To help remedy this, outcome research is necessary. Potentially the results of this research can then be used to modify the guidelines and move provider behavior in the appropriate direction.

Risk Adjustment

The goal of outcome research is to determine the relationship between treatment and outcomes; however, treatment does not work in isolation. Treatment is influenced by patient risk factors. Therefore, researchers must assess this influence and find a way to correct for the differences in the composition of patients being treated. Risk adjustment includes such factors as patient demographics, psychosocial variables, clinical characteristics, and status at the time of treatment. Identified risk factors can be weighted as to their individual impact on the outcome (Kane, 1997), thus creating a more level playing field.

For purposes of risk adjustment, it is important to identify one diagnosis as the primary diagnosis and treat the comorbidities as modifiers. Diagnoses can be further

refined by addressing characteristics that suggest varying prognoses. Researchers should be concerned with characteristics such as severity measures, duration of the problem, and history of previous episodes. In outcome research, all potential differences between groups need be considered to gain greater acceptance of the results (Kane, 1997). Given the numerous potential differences, it is essential to have a conceptual model that describes the assumptions about what influences outcomes and how these factors might be related to each other. Such a model can serve as a guide for both data collection and analysis (Kane, 1997).

Verran (1997) has proposed such a model (Figure 1). Verran's theory-driven framework defines the interrelationships among technology, structure, and outcomes. The model proposes that technology has a causative influence on structure and technology and structure together determine the goals that can be achieved. Risk adjustment factors are included in the concepts of technology and structure. Verran (1997) defines technology as the knowledge required to perform the work and the materials used to accomplish the task. Technology is broken down into two constructs: knowledge technology and materials technology. Materials technology descrobes the nature of the client with whom the nurse deals, and includes such factors as patient demographics and severity of illness (Table 1). Knowledge technology is the process component and includes factors such as interventions and intensity of care. Structure is divided into internal and external context. Internal context includes the human, fiscal, and material resources required to do the work. External context is defined as the environment outside the working group, for example, information transfer across settings. Verran's (1997)

theory-driven framework provides an excellent guide for the analysis of outcome

management of pediatric asthma.

Figure 1. Verran's Framework.
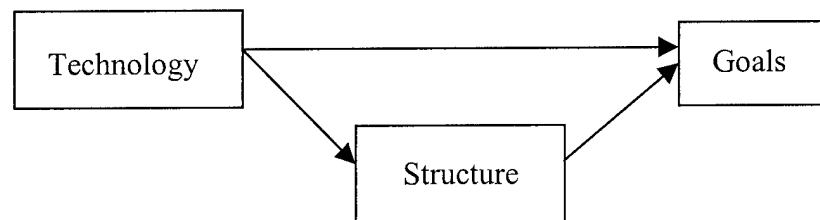
Figure 1. Adapted from the Theory-Driven Framework (Verran, 1997, p.171).

Table 1

Construct, concept, and operational levels of Verran's Framework with examples from the pediatric asthma population.

Construct Level: Materials Technology
Concept Level: The nature of the client with whom the nurse deals
Operational Level:
- Risk Factors
- Client demographics and socioeconomic factors
- Complexity of problem

Construct Level: Knowledge Technology
Concept Level: The knowledge and materials required to perform the work
Operational Level:
- Intensity of Care
- First line interventions

Construct Level: Internal Context
Concept Level: The human, material, and fiscal resources required to perform the work
Operational Level:
- Availability of devices
- Standardization of work
- Nursing skill mix

Construct Level: External Context
Concept Level: The variables outside the work group
Operational Level:
- Presence of pediatric asthma specialists
- Presence of support personnel
- Information transfer across settings
- Geographic location

Construct Level: Goal
Concept Level: Desired outcome
Operational Level:
- Resolution of exacerbation
- Emergency department discharge

Note: Based on Verran's Theory-Driven Framework (Verran, 1997).

Department of Defense Health Care System

The DoD employs 1.4 million men and women on active duty, 672,000 civilians, and 1.28 million guardsmen and reservists. The DoD also supports 1.8 million retirees and families that are receiving benefits. One of the included benefits is TRICARE, the military health care program. TRICARE is guided by principles that guarantee a superior health care benefit, optimization of health care resources, and integration with civilian health care (Sears, 2000).

The National Quality Management Program (NQMP) is the utilization management and quality improvement oversight program of TRICARE. The program consists of six components: readiness, accreditation, credentialing and privileging, licensure, national practitioner data bank, and external review. The external review component contains the tools that allow TRICARE to oversee utilization and risk management and to make quality management decisions. The findings are then used to provide and update existing policies.

Special studies are conducted within TRICARE to identify those practices associated with the most effective outcomes and the most efficient resource use. The military treatment facilities (MTFs) achieving the best practices can serve as a benchmark and their practices translated into clinical pathways. The results of the studies are communicated at least yearly.

In 1994, it was evident to the DoD that there was a lack of data on asthma treatment and outcomes, which hindered efforts to improve clinical care for asthmatic children. Thus, the medical advisory panel of the DoD civilian external peer review

program recommended conducting a study to measure adherence to the NHLBI

guidelines at 11 MTFs with the most frequent asthma hospitalizations. The study

analyzed therapy and outcomes for asthmatic patients treated in 1993. In 1997, a follow-

up study was conducted by the NQMP to evaluate the management of pediatric asthma

and the use of the NHLBI guidelines. The study's results were then compared to the

results of the 1994 study. After the NHLBI guidelines were refined and republished in

1997, the DoD officially adopted the guidelines as standards for practice (Joseph, 1996).

A third study, the Pediatric Asthma Quality Management Review, was conducted in

1998. The report from the third study evaluated the ED management of pediatric asthma

patients and their outcomes, as well as the adherence to NHLBI guidelines in the selected

11 MTFs. The data collected in the 1998 review will be used in this study to conduct a

secondary analysis.

<div align="center">Statement of the Purpose</div>

The purpose of this secondary analysis was to use Verran's framework (1997) to

explore the data obtained in the 1998 Review. Specifically, this study was to evaluate

whether variations in knowledge technology and materials technology of pediatric asthma

patients experiencing severe exacerbations influence hospitalization as an outcome, when

controlling for the same type of facility.

<div align="center">Statement of the Problem</div>

Various practice patterns that include the NHLBI guidelines have been advocated

to improve acute asthma care; however, few studies have demonstrated their

effectiveness. While the NHLBI guideline is a reference to help give direction to current

therapy, there is a need for studies to determine whether using this guideline results in improved clinical outcomes. However, to test whether the NHLBI recommended intervention strategies result in improved outcomes, an understanding of risk factors is also necessary. Outcome studies like this are essential for widespread acceptance of, adherence to, and overall success of the guideline.

Research Questions

This research was designed to answer the following questions regarding ED care of the pediatric asthma patient with severe exacerbations within the DoD population:

1. Does variation in materials technology influence hospitalization as an outcome, when controlling for external structural context?

2. Does variation in knowledge technology influence hospitalization as an outcome, when controlling for external structural context?

Definitions

Asthma: A chronic inflammatory disorder of the airways.

Asthma exacerbation: An increase in the seriousness or severity of asthma as marked by a greater intensity of signs and symptoms of the patient, categorized as mild, moderate, or severe.

Goals: Changes as a result of the care provided. Outcomes. (Verran, 1997).

Hypoxemia: An abnormal deficiency of oxygen in the arterial blood.

Knowledge technology: The knowledge required to perform the work and the materials used to accomplish the task. Process components. (Verran, 1997).

Materials technology: The nature of the client with whom the health care professional deals. Natural raw materials. (Verran, 1997).

Peak expiratory flow rate (PEFR): A measurement of how well air moves out of the lungs. It is measured with a peak flow meter. It is a key tool for monitoring asthma severity and acute management of flares and detect narrowing in the airways hours, even days, before any asthma symptoms are exhibited.

Severity: The subjective and objective ratings of asthma exacerbation by the child, parent, and/or health care professional.

Spirometry: A pulmonary function test that measures the maximal volume of air forcibly exhaled from the point of maximal inhalation (forced vital capacity, FVC) and the volume of air exhaled during this maneuver in the first second (forced expiratory volume in 1 second, FEV_1). Airflow obstruction is indicated by reduced FEV_1/FVC values relative to reference or predicted values (NAEPP, 1997).

Technology: The knowledge required to perform the work and the materials used to accomplish the task (Verran, 1997).

Significance to Nursing

Nurses are certain to be involved in changes in health care delivery and play a key role in creating changes that benefit patient care and outcomes. Nurses have an important voice in the way care is given and its comprehensiveness and achievement of beneficial outcomes. Emergency care can no longer be thought of as simply a 'quick fix' environment for certain illnesses, such as asthma. Asthma is a complex disease that requires a multidisciplinary effort in meeting the child's health care needs. Appropriate

care requires that the nurse be familiar with asthma guidelines that are available for asthma management, work to ensure that the guidelines the organization has adopted are followed, and see that care is delivered effectively, efficiently and rapidly. With knowledge of the effectiveness of interventions that achieve beneficial outcomes, this process can be enhanced. Nurses can inventory existing approaches to asthma care in terms of type and quality of information the programs provide, hence becoming key players in the intervention of poor asthmatic outcomes.

With the establishment of diagnostic and treatment guidelines, nurse-initiated critical pathways for the asthmatic patient are becoming more common. Nurses are often the first health care professional to encounter, screen, assess severity level, and initiate treatment of the child with asthma. Additionally, nurses need to be able to recognize changes before and after interventions. It is, therefore, important that nurses understand what factors affect variations in asthmatic outcomes. With the incidence of asthma continuing to rise, understanding what variables are involved in managing the disease and what outcomes are anticipated is imperative.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Chapter Two provides a description of the conceptual framework and a review of the literature relevant to this study. A framework developed by Verran (1997) was selected to guide this research. The review of literature includes information on client factors associated with asthma, pathophysiology, intensity of care, intervention applications, structural components, and outcomes, as related to Verran's Theory-Driven Framework (1997).

Description of the Theory-Driven Framework

One of the first critical steps in conducting outcomes research is the determination of what conceptual model, or theory, to base the research. Verran (1997) contends that

theory-based research is required for the building of science and for the generalization of results to other situations...Without the use of theory, research ends up focusing on specific problems rather than on the underlying factors that contribute to the situation (p. 169).

Assessment of practice effectiveness includes determining the type of structure and process that results in the best outcome. Evaluation of outcomes is meaningless without the consideration of these two aspects of quality (Mark, 1995). For example, organizations may propose reasons why certain elements or factors should lead to certain outcomes, but if these elements are never tested, we are left to accept assumptions without data to validate the relationships proposed.

An adaptation of Verran's Theory-Driven Framework (1997) provided the

framework for this study (Figure 2). The framework defines interrelationships between

technology, structure, and goals. The model proposes that technology has a causative

influence on structure and together, technology and structure, determine the goals that

can be achieved.

Figure 2. Verran's Framework.
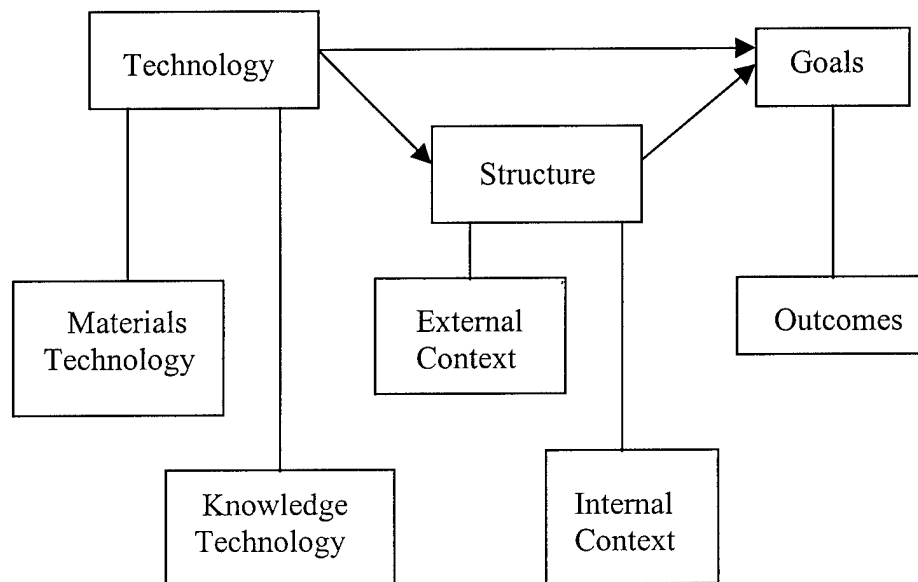
Figure 2. Adapted from the Theory-Driven Framework (Verran, 1997, p.171).

Technology

Verran (1997) defines technology as the knowledge required to perform the work

and the materials used to accomplish the task. Technology consists of two categories:

materials technology and knowledge technology. Together, materials and knowledge

technology have a causative influence on structure. Materials technology includes the

nature of the client with whom the nurse deals (Verran, 1997). Verran (Personal communication, February 2, 2000) also refers to materials technology as natural raw materials. Client problems, knowledge of the client, client variability, and client demographics are factors included in materials technology. It is important to adjust variations in outcomes for differing states of client health, demographics, and disease risk (Mitchell, Ferketick, & Jennings, 1998).

Process components are included in Verran's second technology construct, knowledge technology. Verran (1997) models this idea after Perrow's (1979) work, which proposes that the technology of an organization determines its structure and thus, the goals, or outcomes, that can be achieved. Knowledge technology is defined as the knowledge required to perform the work (Verran, 1997). Simply stated, it is what is done and how well it is done. Included in the knowledge technology construct is the amount of experience and knowledge required to handle the raw material (J.A. Verran, personal communication, February 2, 2000). Direct and indirect interventions, analysis of strategies, and intensity of care are knowledge technology examples.

Structure

In Verran's theory, structure takes the form of internal and external contexts of the work group. Both the internal and external contexts can largely impact outcomes. Internal context refers to human, material, and fiscal resources required to perform the work (J.A. Verran, personal communication, February 2, 2000). For example, appropriate nursing skill mix is an example of an internal structural variable that has been shown to be a factor in improved outcomes (Shaughnessy, Kramer, Hittle, & Steiner, 1995).

External context includes those variables outside the work group, but could be within the organization or community. In this case, access to pediatric pulmonologists potentially would improve outcomes. These variables include such elements as multidisciplinary and organizational resources (J.A. Verran, personal communication, February 2, 2000). An external variable might be where the care was received, for example, in the civilian versus military sector.

Goals

Goals, or outcomes, are defined as changes that result from the care provided. Outcomes are usually thought of in terms of the client's outcomes. However, Verran (1997) contends that outcomes can be organized and measured on three levels: individual, staff, and organizational. Individual, or client, outcomes are problem or disease specific. Group level outcomes might be global measures or information aggregated from the individual level (J.A. Verran, personal communication, February 2, 2000). Examples of staff and organizational level outcomes might be staff turnover rate and a Health Maintenance Organization's mammography rates. When working with outcomes, it is also important to look at the outcome in terms of timing: initial, intermediate, and final (J.A. Verran, personal communication, February 2, 2000). An example of an initial outcome might be whether or not a client received all the discharge planning needed to start self-care, with the intermediate outcome being the level of self care and the final outcome being the client going back to work.

Application of the Theory-Driven Framework

The conceptual framework for this study consists of these constructs: technology, structure, and goals (Verran, 1997). These constructs and their relationships formed the framework to guide this study. Using a framework to guide outcomes research makes the scientific findings meaningful and allows for generalization to other studies. The concepts from Verran's Theory Driven Framework (1997) were operationalized in this research to reflect a combination of client factors and intervention applications that predict outcomes while controlling structure. Table 1 introduced the conceptual framework at the construct, concept, and operational levels, providing examples from the pediatric asthma population. Table 1 will serve as an outline for the literature review that follows.

Literature Review

In the following section, the literature review has been organized by the components of Verran's Framework (1997).

Technology

Table 2 highlights the key materials and knowledge technology factors that are applicable to the pediatric asthma population.

Table 2

Technology construct, concept, and operational levels

Construct Level: Materials Technology
Concept Level: The nature of the client with whom the nurse deals
Operational Level (Asthma examples):
- Risk Factors
  - Previous life threatening exacerbations
  - Previous ED/inpatient admissions in past 12 months
  - Use of ≥ 3 asthma medications to control symptoms
  - Psychological/psychosocial problems
  - Non adherence
- Client demographics and socioeconomic factors
  - African American and Hispanic races
  - Poverty
  - Urban residence
  - Large family size
  - Crowding
  - Maternal smoking
  - Low birth weight
  - Exposure to cockroaches
- Complexity of problem
  - Pathophysiology

Construct Level: Knowledge Technology
Concept Level: The knowledge and materials required to perform the work
Operational Level:
- Intensity of Care
  - Asthma assessment
- First line interventions
  - Oxygen
  - Inhaled Beta$_2$-agonists
  - Inhaled Corticosteroids

Materials Technology

Materials technology is the natural raw materials or the nature of the client with whom the nurse deals (Verran, 1997).

Risk Factors

Asthma is the most common illness affecting children, with a prevalence in the United States estimated at 74.9 per 1,000 persons in 1995, for aged 18 years and younger (CDC, 1999). The CDC (1999) reported that from 1980-1994, the most substantial increase in prevalence was seen among children aged 0 to 4 years (160%, 22.2 per 1,000 to 57.8 per 1,000) and persons aged 5 to 14 years (74%, from 42.8 per 1,000 to 74.4 per 1,000). The increase in asthma morbidity is reflected in lost days from school, worsening quality of life, increased emergency department visits, and increased hospitalization rates (CDC, 1998; Ray, Thamer, Fadillioglu, & Gergen, 1998). Hospitalization rates among children have rapidly increased between 1979 and 1994, with the highest asthma hospitalization rates in children aged 0 to 4 years (CDC, 1998). Furthermore, asthma mortality for children aged 5 to 14 years has increased by approximately 10% per year (Weiss & Wagener, 1990). It is obvious why pediatric asthma is receiving national attention; however, explanations for this rising prevalence, morbidity, and mortality variy. Risk factors for this increased morbidity and mortality include previous life-threatening exacerbation, previous hospital admission or emergency department visit within the past 12 months, use of three or more medications to control symptoms, psychological/psychosocial problems, and non adherence (Cohen, Eigen, & Shaughnessy, 1997; Sly & O'Donnell, 1997; Strunk, Mrazedk, Wolfson-Fuhrmann, & LaBrecque,

1985). These risk factors fall under client variability within Verran's (1997) concept of materials technology.

Client Demographic and Socioeconomic Factors

Client demographics and socioeconomic factors also fit within Verran's (1997) materials technology. Researchers have reported many conflicting results about whether or not there is an association between prevalence of asthma and socioeconomic factors. Some studies have identified racial, social, and environmental factors that appear to be associated with an increased risk of asthma (Rosenstreich, et al., 1997; Watson, Cowen, & Lewis, 1996; Weitzman, Gortmaker, & Sobol, 1990), while others show no relationship (Gergen, Mullally, & Evans, 1988; Horwood, Fergusson, & Shannon, 1985; Lee, Winslow, Speight, & Hey, 1983). The racial, social, and environmental factors most commonly discussed include African American or Hispanic race, poverty, urban residence, large family size, crowding, maternal smoking, low birth weight, and exposure to cockroaches. Even in studies that report a correlation among risk factors, the exact relationship between these factors and childhood asthma remains unclear. For example, a number of studies have found black children in the United States (U.S.) to have higher rates of asthma than white children (NAEPP, 1997). One study (Weitzman, Gortmaker, and Sobol, 1990) concluded that much of the observed racial disparity is actually due to social and environmental differences.

Understanding the role socioeconomic factors play is important because they may correlate not only with an increased risk of asthma, but also with the severity of the condition. Several studies concluded that poverty is a major predictor of the rate of

asthma hospitalizations (Watson, Cowen, & Lewis, 1996) and has been correlated with

asthma severity (Wissow, Gittelsohn, Moyses, Starfield, & Mussman, 1988).

Identification of racial and socioeconomic influences can provide clues to prevention and

more effective treatments of asthma. Furthermore, studies have demonstrated that these

factors can contribute to differences in outcomes (Crain, Weiss, & Fagan, 1995;

Finkelstein, et al., 1995).

Asthma Pathophysiology

The pathophysiology and complexity of the problem are also factors within

Verran's (1997) concept of materials technology. Asthma is an illness that varies greatly

in predisposing factors, symptom severity, diagnosis, and treatment, all of which can

affect outcomes. Asthma is defined as a chronic inflammatory disorder of the airways in

which many cells and cellular elements play a role. In susceptible individuals, this

inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and

cough. These episodes are usually associated with widespread but variable airflow

obstruction that often reverses either spontaneously or with treatment. The inflammation

also causes an associated increase in the existing bronchial hyperresponsiveness to a

variety of stimuli, known as 'triggers' (NIH, 1995). Triggers include such things as

allergens, environmental irritants, respiratory infections, stress, exercise, and

medications.

Asthma results from complex interactions among inflammatory cells, mediators,

and other cells and tissues in the airways. Mast cells, eosinophils, epithelial cells,

macrophages, and activated T cells are key features of the inflammatory process of

asthma (Djukanovic, et al., 1990). These cells influence airway function. Cell-derived mediators influence airway smooth muscle tone, modulate vascular permeability, activate neurons, stimulate mucus secretion, and produce characteristic structural airway changes (Horwitz & Busse, 1995). Furthermore, T lymphocytes regulate allergic inflammation in the airway and establish disease chronicity (Robinson, et al., 1992). Together, these factors are important in both the initiation and maintenance of airway inflammation (Robinson, Durham, & Kay, (1993).

Triggers cause a release of mediators from mast cells that include histamine, tryptase, leukotrienes, and prostaglandins, which contract the smooth muscle (Marshall & Bienenstock, 1994; Sheth & Lemanski, 1991). The released mediators cause increased microvascular permeability and leakage, which contribute to mucosal thickening and swelling of the airway. This swelling causes airways to become more rigid and interfere with airflow. The released mediators also stimulate mucus secretions that cannot be effectively cleared due to the mucociliary abnormalities and bronchial obstruction from injured epithelium (van der Jagt, 1998).

Increased bronchial smooth muscle tone, inflammatory edema of the airways, and increased mucus production result in airways with difficult air entry, air trapping, and impaired oxygen and carbon dioxide exchange in the lungs (Webb, et al., 1992). To maintain airflow, the child must work harder to breath, resulting in an accelerated respiratory rate and use of accessory muscles. Inspiration becomes more difficult, while expiration, which is normally a passive function, requires effort (van der Jagt, 1998).

When asthma begins in childhood, it is frequently found in association with atopy, which is the genetic susceptibility to produce IgE directed toward common environmental allergens (Larsen, 1992). Atopy is one of the strongest predisposing factors in the development of asthma (Sporik, Holgate, Platts-Mills, & Cogswell, 1990). Additionally, wheezing with viral infections, allergies, or family history of allergies have been found to be factors strongly associated with childhood asthma (Martinez, et al., 1995). These pathophysiologic factors can fluctuate in magnitude and contribute to variable outcomes.

Knowledge Technology

Knowledge technology variables are those practices known to influence outcomes, including intensity of care. To provide proper treatment of asthma that directly affects the client outcome, it is necessary to assess the severity of the exacerbation. However, this proves difficult in children. The child must be evaluated quickly, accurately, and efficiently. The assessment should begin with a clinical evaluation with immediate attention paid to airway, breathing, and circulation. Second, a brief history, including length of the current exacerbation, current medications, and increase in frequency of inhaled/rescue medications, should be obtained as allowed, while treatment is given (Adams & Martin, 1992; NIH, 1997; Smith & Strunk, 1999; van der Jagt, 1998). This information may help determine the initial severity level of the attack. Although inquiry about the child's subjective symptoms should also be accomplished, many children do not have the ability to assess the severity of their illness (Linna, 1994) and parents often underestimate the child's level of severity (Yoos & McMullen, 1999).

Asthma Assessment

Pulmonary function tests provide objective evidence regarding asthma severity

(Danielle, et al., 1994; Smith & Strunk, 1999; van der Jagt, 1998). Research supports the

conclusion that measurements of lung function are critical for accurately assessing both

the severity of condition and response to treatment (Guyatt, Walter, & Norman, 1987;

McDermott, 1993; Sackett, Chambers & Macpherson, 1977). One lung function measure

is spirometry. Although very accurate in assessing asthma severity, it is rarely used due to

the lack of special equipment in many emergency departments. Another method, the peak

expiratory flow rate (PEFR), correlates with the forced expiratory volume in one second

(FEV_1) (Smith & Strunk, 1999). The degree of obstruction is estimated by comparing the

child's PEFR to his/her personal best or a PEFR chart, which has standard values

predicted from height. Both methods prove difficult in children and are not suitable for

children under five years of age. These measures take effort, active cooperation, and are

technique dependent. Children may require practice before producing accurate measures.

Furthermore, children who are significantly distressed have difficulty performing PEFRs

(Danielle, et al., 1994; Smith & Strunk, 1999). Ducharme & Davis (1997) concluded that

as many as 40% of young and acutely ill children may be unable to perform a PEFR test.

Therefore, other measures of severity are imperative in the assessment of asthma

exacerbations in children.

Clinicians must use clinical signs to assess the severity level and evaluate

treatment efficacy of asthma in children. A single clinical sign is not indicative of asthma

severity; a combination of signs provides more valid information to the severity of

asthma (Danielle, 1994; Kerem, et al., 1990). Many asthma severity scores have been described in the literature; however, most of these scores have not been validated (Smith & Strunk, 1999) or have only been used once or twice (Danielle, et al., 1994). Furthermore, subsequent studies often fail to confirm the accuracy of the scores (Rose, Murphy, & Schwartz, 1984; Centor, Yarbrough, & Wood, 1984) or conflicting results are obtained when the scores are applied to children (Kerem, et al., 1990). These scales include the Pulmonary Index (Becker, Nelson, & Simons, 1984), the Clinical Asthma Score (Wood, Downes, & Llecks, 1972), the Clinical Scoring System (Kerem, et al., 1990), the Asthma Severity Scale (Bishop, Carlin, & Nolan, 1992) and the Pulmonary Score (Smith, Hodge, & Baty, 1998). Additionally, in the NHLBI guidelines, the National Asthma Education Panel has published a figure for assessing asthma exacerbation severity. No score is calculated, but it is possible to classify asthmatic exacerbations as mild, moderate, or severe, based on the patient's symptoms (NAEPP, 1997). Research conducted by Rodrigo & Rodrigo (1993) determined that "subjective and objective measures used in the assessment of patients with acute asthma represent separate and nonoverlapping dimensions and provide a useful summary of acute asthma" ($\underline{n}$ = 194) (p. 1328). The assessment measures, or variables, used in their study were categorized into four factors (PEFR, FVC, FEV_1, early response to treatment = Factor 1; respiratory rate, accessory muscle use, dyspnea = Factor 2; heart rate, wheezing = Factor 3; age, duration of attack, steroid use = Factor 4). They concluded that emergency department clinicians should assess information that reflects all four dimensions

Besides assessment of the severity level in the child with acute asthma, there are other unique considerations in the assessment of infants and children. Differences in children's anatomy and physiology place them at greater risk for respiratory failure. Furthermore, in infants the progression from wheezing related to viral infections, to respiratory failure progress rapid. Therefore, close monitoring is crucial. It is also essential to monitor oxygen saturation (SaO_2) by pulse oximetry in children because they can become hypoxemic much quicker than adults (NAEPP, 1997). Studies have demonstrated that in acute childhood asthma, the initial level of SaO_2 is a good predictor of poor outcome, the need for admission, or relapse if sent home (Connett & Lenney, 1993; Geelhoed, Landau, & Souef, 1994). Accurate assessment is imperative in the determination of asthma severity and the choice of interventions that will result in the best outcomes.

Interventions

Other factors included in Verran's knowledge technology are interventions and related activities. Once an asthma exacerbation has been recognized, immediate intervention should begin toward improving the hypoxia, bronchoconstriction, and inflammation (Adams & Martin, 1992). Homer (1997) found that the core recommendations of various guidelines for the management of asthma are consistent (British Toracic Society, 1993; NIH, 1992; NAEPP, 1997). Guidelines for asthma care in the U.S., including emergency department care, are provided by the National Heart, Lung and Blood Institute (NHLBI) of the National Institutes of Health. In the emergency department, the treatment is tailored to the severity of the exacerbation (NAEPP, 1997).

The primary interventions are oxygen administration, inhaled beta$_2$-agonists, and systemic corticosteroids. The dose, frequency, and route of administration for these depend on patient assessment and response to treatments. Figure 3 provides the NHLBI guideline's first-line recommendations for the management of severe asthma exacerbations.

Figure 3. First-line Therapies.

Initial assessment (see Table 4)

- History
- Physical examination
  - o Auscultation
  - o Accessory muscles usage
  - o Heart rate
  - o Respiratory rate
- PEFR or FEV
- Oxygen saturation
- Other tests, as indicated

Severe Exacerbation
First-line therapies

- Oxygen to achieve oxygen saturation $\geq$ 90 %
- Inhaled high-dose beta$_2$-agonist and anticholinergic by nebulization every 20 minutes or continuously for 1 hour
- Oral systemic corticosteroid

Figure 3. Adapted from Figure 3-11, Management of asthma exacerbations: Emergency department and hospital-based care (National Institutes of Health, 1997, p. 112)

Oxygen Administration

It is generally agreed that oxygen saturation should be obtained on all children to assess the degree of hypoxia. However, there is debate among researchers as to what SaO_2 level is acceptable in the child with an asthma exacerbation before supplemental oxygen is needed (Smith & Strunk, 1999). Ros (1991) noted that even though children appear to have normal oxygenation upon physical examination, they often can be hypoxemic. Some researchers have identified respiratory distress and documented hypoxemia as the factors determining when oxygen is required (Adams & Martin, 1992; van der Jagt, 1998), while the NHLBI guidelines recommends that supplemental oxygen should be given by nasal cannulae or mask, whichever is best tolerated, for a $SaO_2 \leq 91\%$ (NAEPP, 1997). Varying institutions, clinicians, and investigators use different cutoff points, between 90-95% (Smith & Strunk, 1999). Additionally, van der Jagt (1998) identified that when the child is receiving oxygen therapy, it is not necessary to maintain a SaO_2 greater than 92% via higher oxygen concentrations because of the potential for alveolar collapse and resulting atelectasis and increased hypoxemia.

Inhaled Beta$_2$-Agonists

Inhaled, or nebulized, beta$_2$-agonists are recommended as a first-line pharmacologic intervention for all children for the treatment of bronchoconstriction, regardless of asthma severity (NAEPP, 1997; Smith & Strunk, 1999; van der Jagt, 1998). Albuterol is the most common beta$_2$-agonist given. A number of studies have been conducted to evaluate different dosing regimens and mechanisms of administration of albuterol. The optimal dose and frequency continues to be debated. Some researchers

concluded that continuous delivery has an advantage over intermittent, arguing that continuous treatment decreases the risk for undertreatment, may improve PEFR better than intermittent treatment, and decreases the length of stay in the emergency department (Kelly & Murphy, 1992; McFadden, et al., 1998; Papo, Frank, & Thompson, 1993). Other studies have found no therapeutic differences between intermittent and continuous delivery of beta$_2$-agonists (Khine, Fuchs, & Saville, 1996; Rudnitsky, et al., 1993). The NHLBI guidelines recommend repetitive (every 20 minutes) or continuous administration of an inhaled short acting beta$_2$-agonist (NAEPP, 1997). It is suggested that treatments be given every 20 to 30 minutes initially and then, if there is poor response, the child should be placed on continuous treatments (NAEPP, 1997; van der Jagt, 1998).

Studies have demonstrated that metered-dose inhalers, dry-powder inhalers, or nebulizers are equally effective in beta$_2$-agonist delivery (Cohen, Eigen, & Shaughnessy, 1997; Idris, et al., 1993; NAEPP, 1997). However, as many as 90% of adults do not know how to properly use a metered-dose inhaler (Idris, et al., 1993). In contrast, Idris, et al. (1993) demonstrated that children as young as 10 years of age, who used a metered dose inhaler with an attached spacer/holding chamber and the supervision of trained personnel, could get results equivalent to using a nebulizer ($n = 35$). Ultimately, the mode of beta$_2$-agonist delivery might be dependent on the child's age and distress level.

Many studies have demonstrated that when anticholinergic medication is added to albuterol, there is additional bronchodilation, improved PEFRs, and decreased emergency department length of stay times (Brophy, et al., 1998; Greenough, Yuksel, Everett, & Price, 1993; Nichols, 1996; Qureshi, Zaritsky, & Lakkis, 1997; Schuh, et al., 1995;

Stokes, Milner, Hodges, & Henry, 1983; Zorc, Ogborn, & Pulsic, 1998). Furthermore,

studies have shown a decreased hospitalization rate for children with severe asthma when

using an anticholinergic as an additive with albuterol (Kapel, et al., 1996, Nichols, 1996;

Qureshi, et al., 1998; Zorc, Ogborn, & Pulsic, 1998). Ipratropium bromide is the most

common anticholinergic medication given for asthma therapy. Ipratropium bromide is

similar to atropine except that it contains an ammonium group that prevents systemic

absorption (Zorc, Ogborn, & Pulsic, 1998). The resulting effect of Ipratropium bromide is

bronchodilation. Ipratropium bromide alone is not recommended and is not considered a

first-line therapy (NAEPP, 1997).

The most beneficial anticholinergic dosing regimen has not been determined

(Kapel, et al., 1996; Nichols, 1996; Qureshi, et al., 1998; Zorc, Ogborn, & Pulsic, 1998).

Smith and Strunk (1999) concluded that 0.25 mg to 0.50 mg Ipratropium bromide

together with albuterol can be given every 15 to 20 minutes for one to three treatments.

van der Jagt (1998) concluded that Ipratropium bromide with albuterol can be given

every 20 minutes for the first hour and then every two to four hours, if necessary . The

NHLBI guidelines recommends an inhaled high-dose beta$_2$-agonist together with 0.25 mg

anticholinergic by nebulization every 20 minutes or continuously for one hour in

children, particularly those with severe airflow obstruction, as first-line therapy (NAEPP,

1997).

Corticosteroids

Since asthma has been determined to primarily be an inflammatory illness,

corticosteroids should be considered for all children with asthma who present to the

emergency department (Smith & Strunk, 1999). Corticosteroids directly aim at preventing progression of the inflammatory response and reducing the inflammation (van der Jagt, 1998). The NHLBI Guidelines recommends corticosteroids for patients who have moderate to severe exacerbations and patients who have only a partial response the beta2-agonist therapy (NAEPP, 1997). In children, it is especially important to give corticosteroids early in the course of treatment (Harris, et al., 1987) because it takes approximately 4 to 6 hours for steroids to demonstrate their clinical benefit (Barnett, Caputo, Baskin, & Kuppermann, 1997; Smith & Strunk, 1999; van der Jagt, 1993).

Controversy exists about how corticosteroids should be administered. Methylprednisolone, or prednisone, is the corticosteroid most often used. While many clinicians administer corticosteroids intravenously (IV) because of assumed quicker onset of action and more reliable results (Barnett, et al., 1997), a number of studies have evaluated the benefits of oral steroids. Barnett, et al. (1997) demonstrated that in children with mild to severe asthma exacerbations, hospitalization rates were similar between children receiving oral methylprednisolone and children given the same medication IV (n = 49). Many other factors should be considered in how corticosteroids should be administered to children. Oral corticosteroids are easier to administer, less expensive, and may be safer, however they do have a bitter taste, which may result in vomiting (Barnett, et al., 1997). IV placement in children is often difficult, frightening, and painful. Intramuscular (IM) administration involves constraining the child for a prolonged period of time, is painful, and can cause subcutaneous fat necrosis if done incorrectly (Smith & Strunk, 1999). Therefore, many investigators prefer the oral administration of

corticosteroids, especially with children (NAEPP, 1997). van der Jagt (1998) concluded that it is appropriate to give an oral corticosteroid to the child with a mild or moderate exacerbation very soon after the first inhaled beta$_2$-agonist treatment. Patients who are unable to take oral medications, are vomiting, are severely ill, or have a worsening clinical picture should be given the corticosteroid IV (van der Jagt, 1998; Smith & Strunk, 1999).

Therapies Not Recommended

A number of therapies are no longer recommended for the treatment of children with acute asthma. Theophylline is not recommended (van der Jagt, 1998; NAEPP, 1997). Studies have demonstrated that theophylline provides no additional benefit over optimal beta$_2$-agonists and corticosteroids (Bien, et al., 1995; Carter, et al., 1993; DiGiulio, et al., 1993; Rodrigo & Rodrigo, 1994). Furthermore, the side affects of theophylline are unpleasant (van der Jagt, 1998) and its use may increase adverse effects (NAEPP, 1997). The exception to this might be the patient who has clearly responded to theophylline in past exacerbations (van der Jagt, 1998). Additionally, patients who are currently taking a theophylline-containing preparation at home should have a serum theophylline concentration checked in the emergency department to rule out theophylline toxicity (NAEPP, 1997) or low levels (van der Jagt, 1998). Antibiotics are not recommended for treatment of acute asthma, however may be necessary for comorbid conditions, e.g. patients with evidence of pneumonia. Aggressive hydration is not recommended for older children but might be necessary for infants and younger children. Infants and young children may rapidly dehydrate due to increased respiratory rate and

decreased oral intake. In these cases, assessments of fluid status should be made and appropriate fluid corrections provided. Chest physical therapy is not beneficial and is stressful for the breathless patient. Mucolytics are not recommended because they may worsen cough or airflow obstruction. Anxiolytic and hypnotic sedation drugs should be avoided because of their respiratory depressant effect (NAEPP, 1997).

Structure

Structure assumes the form of internal and external context, both largely impacting outcomes. Table 3 outlines the key structural factors.

Table 3

Structure construct, concept, and operational levels

Construct Level: Internal Context
Concept Level: The human, material, and fiscal resources required to perform the work
Operational Level:
- Availability of devices
- Standardization of work
- Nursing skill mix

Construct Level: External Context
Concept Level: The variables outside the work group
Operational Level:
- Presence of pediatric asthma specialists
- Presence of support personnel
- Information transfer across settings
- Geographic location

Internal Context

Verran's concept of internal context refers to such things as human, material, and fiscal resources. Fitzgerald, Freund, Hughett, and McHugh (1993) reported that differences in hospital size, teaching affiliation, and location might reflect differences in their structural elements, especially the availability of devices. For example, a teaching facility may have more sophisticated devices. When devices are not available or personnel do not know how to use them, inadequate assessment of asthma severity could occur and significantly affect outcomes (Fitzgerald, et al., 1993). For example, even though spirometry has been demonstrated to be very accurate in the assessment of asthma exacerbation severity, most emergency departments do not carry the specialized equipment. Furthermore, even if clinicians wanted spirometers in their emergency department, they do not control the budget and hence may be unable to purchase the equipment.

Standardization of work is another variable falling under internal context. This refers to similar work activities being done in the same manner. For example, the use of clinical algorithms and standing orders has been shown to improve delivery of tasks (Litzelman, et al., 1990; Mobley, Altman, & Duvall, 1990) and ensure inclusion of the necessary elements of asthma care.

Another internal context factor associated with care of the asthmatic child in the emergency department is nursing skill mix. This is especially important in the military setting because skill mix can be compromised due to personnel being deployed for wartime or peacetime contingencies. Fitzgerald, Freund, Hughett, and McHugh (1993)

noted that inappropriate use of skills could lead to undesired risk factors or overutilization of resources.

External Context

External context includes those variables outside the work group. An external context factor related to asthma care is the availability or access to specialists if needed, for example, a pulmonologist. Many of the military treatment facilities (MTFs) have been downsized and may not employ specialists. The literature suggests that there are some aspects of specialty care that may lead to better outcomes (Fitzgerald, et al., 1993; Weiss & Budetti, 1993), however most of this research has been conducted in the outpatient setting.

A second factor deals with care of the asthmatic child being multidimensional across environments and often requiring many disciplines. If there is poor information transfer between settings, effective treatment might be compromised (Fitzgerald, Freund, Hughett, & McHugh, 1993). For example, when the asthmatic child is discharged and instructed to follow-up at an outpatient clinic, a mechanism to arrange the follow-up and then assurance that pertinent information is forwarded is required.

Another external context factor is the lack of formal relationships created when a hospital does not have an inpatient unit and the asthmatic child must be transferred for admission. Again, due to downsizing, there are MTFs that do not have critical care or inpatient units. This may hinder the coordination of care of the acutely ill asthmatic child (Fitzgerald, et al., 1993), while also causing frustration to the family and frightening the child.

Geographic area is also a factor of external context. Several investigators have found that hospitalization rates vary among different states and even within a state (Carr, Zeitel, & Weiss, 1992; CDC, 1998; Wennberg, McPherson, & Caper, 1984). Reasons for these geographical variations are uncertain, however the community, health care systems in the area (Weiss & Budetti, 1993), diagnostic and treatment variations (Erzen, Roos, Manfreda, & Anthonisen, 1995; O'Brien, 1995), climatic factors (Lintner & Brame, 1993), and exposure to air pollutants (Schwartz, Slater, Larson, Pierson, & Koenig, 1993; White, Etzel, Wilcox, & Lloyd, 1994) have been suggested to be factors associated with this variation.

Goals

"Disease activity usually dictates which components of care are provided and by which organizations" (Fitzgerald, et al., 1993, MS70). However, understanding the process and structural factors involved with care of the asthmatic child is vital for effective and efficient treatment and achievement of better outcomes. The goal in treatment of asthma exacerbations is resolution of the exacerbation with minimal complications and minimal frequency of relapse (McDermott, 1993). Decision to admit or discharge from the emergency department depends on the child's response to treatment, based on objective pulmonary measurements, symptom resolution, and background risk factors. Researchers suggest that discharge is appropriate when PEFR has returned to 60-70% of personal best or predicted and symptoms are minimal or absent (Emond, Camargo, & Nowak, 1998; McDermott, 1993). However, these studies did not indicate what criteria should be used with the child that cannot provide a PEFR. The

NHLBI guidelines recommends that the decision to admit a patient should be based on the following: duration and severity of symptoms, severity of airflow obstruction, course and severity of prior exacerbations, medication use at time of the exacerbation, access to medical care and medications, adequacy of support and home conditions, and presence of psychiatric illness (NAEPP, 1997). McDermott (1993) noted that risk factors, such as frequent emergency department visits, previous inpatient or intensive care admissions, and previous intubation, increase the chance of poor outcomes.

Summary

Asthma is the most common chronic disease of childhood with increasing rates of morbidity and mortality. Appropriate and available therapies have been identified in the treatment of acute childhood asthma, however ongoing study is needed to identify and investigate differences in procedures or interventions that are associated with differences in outcomes. This can be done using Verran's Theory Driven Framework (1997). Based on the results of these investigations, education and feedback can be used to modify clinician behavior in the appropriate direction (Epstein, 1990). Monitoring outcomes of guideline use and using the results to support or adjust the guideline are important issues associated with guideline success (Webb, et al., 1992).

CHAPTER THREE

METHODOLOGY

Chapter Three addresses the methods used in the original study and this study. The design, sample, setting, protection of human subjects, data collection procedure, and plan for the secondary data analysis are included.

Typically, when conducting primary research, more data are collected than actually analyzed. Even when most data are utilized, there remains more possible ways of examining relationships among the variables than were explored. This is particularly true of large-scale data sets, such as the ones collected by the Department of Defense (DoD). Secondary analysis is extremely valuable in that it is efficient, expedient and economical. Secondary analysis allows one to proceed directly from a research question to testing of the hypothesis.

However, there are limitations in conducting a secondary analysis. If the investigator did not collect the data, the data set may prove to be problematic or deficient. For example, the investigator may have wished additional subjects were included in the sample or different variables measured. Furthermore, the data may be inaccurate. The interviewers may have been inexperienced, questionnaires may have been lost, or errors made during data entry, all of which is unknown to the researcher when conducting a secondary analysis (Polit & Hungler, 1999).

Original Study Design

The original study was the third study commissioned DoD focused on the Emergency Department (ED) management of pediatric asthma patients where hospitalization was most frequent. The goals of the study were to (1) compare therapy practices and outcomes for pediatric asthmatic patients treated in the ED in 11 Medical Treatment Facilities (MTFs), (2) assess adherence to the treatment strategies recommended by the 1997 National Heart, Lung, and Blood Institute (NHLBI) guidelines, and (3) assess the effect of implementing the NHLBI guidelines on ED management and hospitalization of pediatric asthma patients.

A DoD subcontractor completed the analytical process of the original data. The first step in the analysis was to define the outcome measure: a patient who is discharged home after treatments in the ED. Next the patient risk factors were identified through stepwise logistic regression. Third, using multiple regression analysis, resource use was examined and risk adjusted to obtain the predicted resource use values. The predicted admission rates and resource use values were then compared to the actual values. The difference between the actual and predicted values revealed the Clinical Practice Profile (CPP). The CPP provided information as to the relationships between resource use, quantity and intensity of care, and outcomes.

Original Study Sample and Setting

Data were collected from major MTFs across the United States, 2 in the Northwest, 2 in the Northeast, 4 in the Southwest, and 3 in the Southeast. Army, Naval, and Air Force major MTFs range from 30 to 1,000 bed facilities. The MTFs operate

under standards similar to civilian facilities, providing comprehensive medical care to active duty military personnel and dependent and retired beneficiaries. The services provided are comparable to civilian counterparts and range from general medicine to high-risk specialty care. The diversity of the population stems from diverse demographic characteristics and the fact that DoD beneficiaries are located throughout the United States and around the world.

Data were collected during the peak asthma season, between the months of September and December 1997. Inclusion criteria included persons aged less than 17 years, who were treated in the MTF ED for asthma or reactive airway disease. Cases were chosen based on random dates during the study period. The field representatives abstracted the records of a random sample of 100 children per MTF whom the ED treated and diagnosed as having asthma or reactive airway disease on those days.

Original Study Data Collection Procedure

The field representatives reviewed 1,122 records of pediatric asthma patients treated in the EDs of 11 MTFs where asthma hospitalizations were most frequent. Data on the care received in the ED were extracted from DoD electronic databases and on-site chart reviews according to a specific protocol. The extracted data were entered into an electronic research database that was structured around a comprehensive clinical data dictionary that included: (1) presenting symptoms and chief complaints, (2) physical examination findings, (3) laboratory, radiological, and other test results, (4) pharmacological management, and (5) information extracted from military electronic databases.

Protection of Human Subjects

The researcher received approval for secondary analysis of the data from the

University of Arizona Human Subjects Committee (Appendix A). DoD approval for use

of the data was obtained from Lieutenant Colonel James Williamson, Deputy Operations

Director for the Population Health for Clinical Quality Division (Appendix B). Both the

subjects' and MTFs' identifying information were deleted prior to receipt of the data.

Secondary Study Design

The secondary analysis used was an ex post facto retrospective design to evaluate

whether variations in knowledge technology and materials technology of pediatric

patients experiencing severe asthma exacerbations seen in the ED influence the outcome

of hospitalization when structure is controlled. Structural variables were controlled by

limiting subject selection to those pediatric asthma patients seen in an MTF ED. Two

groups of subjects were chosen out of those pediatric asthma patients experiencing severe

asthma exacerbations seen in an MTF ED: (a) Group 1, with the outcome of

hospitalization and (b) Group 2, those without the outcome of hospitalization.

Secondary Study Subject Selection

A combination of clinical signs provides the most valid information as to the

severity of asthma (Danielle, 1994; Kerem, et al., 1990). Many asthma severity scores

have been described in the literature; however, most of these scores have not been

validated (Smith & Strunk, 1999) or have only been used once or twice (Danielle, et al.,

1994). Furthermore, subsequent studies often fail to confirm the accuracy of the scores

(Rose, Murphy, & Schwartz, 1984; Centor, Yarbrough, & Wood, 1984) or conflicting

results are obtained when the scores are applied to children (Kerem, et al., 1990). For these reasons, it was decided to select subjects for the present study using the NHLBI guideline's classification of asthma exacerbation severity (NAEPP, 1997). No score was calculated, but it was possible to classify the asthmatic exacerbation based on clinical signs. Table 4 provides the NHLBI guideline parameters for classification of a severe asthma exacerbation.

Selected subjects were classified as having a severe asthma exacerbation if they met one of the following inclusion criteria:

1. Respiratory rate (RR) 30-45 and oxygen saturation (SaO_2) 91-95%.

2. Respiratory rate (RR) 30-45 and inspiratory wheeze, expiratory wheeze, use of accessory muscles, and dyspnea.

3. Respiratory rate (RR) 30-45 and severe dyspnea.

4. RR > 60.

5. SaO_2 91-95% and severe dyspnea.

6. SaO_2 91-95% and inspiratory wheeze, expiratory wheeze, use of accessory muscles, and dyspnea.

7. SaO_2 < 91%.

Table 4

Parameters Classifying Severe Asthma Exacerbation

Severe Asthma Exacerbation		Available in Data Set
Symptoms		
Breathlessness	While at rest (infant – stops feeding) Sits upright	Yes
Talks in	Words	No
Alertness	Usually agitated	No
Signs		
Respiratory Rate	Often > 30 / minute	Yes
Use of accessory muscles; suprasternal retractions	Usually	Yes
Wheeze	Usually loud; throughout inhalation and exhalation	Yes
Pulse/minute	> 120 / minute	Yes
Pulsus paradoxus	Often present > 10-40 mm Hg	No
Functional Assessment		
PEF (% predicted or personal best)	< 50% predicted or personal best	Yes
PaO2 (on air) and/or	< 60 mm Hg	No
PCO2	> 42 mm Hg	No
SaO2 % (on air) at sea level	< 91 %	Yes

Note: Adapted from Figure 3-9 in NHLBI guideline (NAEPP, 1997, p. 109).
The presence of several of the parameters, but not necessarily all, indicates the general classification of the exacerbation.

Peak expiratory flow rate (PEFR) was not included in classifying the asthma exacerbation due to the amount of missing data. Additionally, pulse rate was not included due to the variety of factors beyond the asthma exacerbation that might have affected the child's heart rate.

Subjects who met the selection criteria and were hospitalized were placed in Group 1. The remaining subjects who met the severity criteria but were not hospitalized constituted Group 2.

Data Analysis

The data consisted of some ordinal and interval levels of measurement; however, the majority of the data was categorical. Two techniques are generally used to evaluate group membership with dichotomous variables, discriminant function analysis and logistic regression (LR). Discriminant function analysis provides a set of predictor variables that distinguishes among groups. Discriminant function analysis is sensitive to the assumption of normality and will overestimate the magnitude of the association when using dichotomous independent variables. Therefore, the assumption of multivariate normality of the independent variables and equal variance-covariance matrices in the two groups must be met for optimal results (Munro, 1997).

Munro (1997) defines LR as a statistical technique designed to determine which variables affect the probability of an event. The LR technique allows researchers to predict outcomes and explain the interrelationships among variables. Furthermore, LR can be used to compare groups of similar subjects consisting of one group with the outcome being analyzed and the other group without. Determinations can then be made

as to which risk factors had the most impact on the outcome. People who have studied both methods have found LR to be better suited to dichotomous data and prefer this method of analysis (Munro, 1997).

The DoD subcontractor used the Stata Corporation's statistical computer program STATA ^{TM} to compile the original data. The database was imported into SPSS ® Statistical Program for Social Sciences (SPSS) for analysis. SPSS was used to perform descriptive statistics and LR to answer the research questions. Using SPSS, the data were recoded and grouped as necessary to allow statistical analysis. All subjects meeting the criteria for Group 1 were coded as (1) and all other subjects (Group 2) were coded as (0). An analysis of differences (t-tests and Chi square) was done on all the variables. Those variables found to have significant differences between Groups 1 and 2 were placed into the LR equation in blocks. Blocks were used to assist in formulating a method for variable entry into the equation. The material variables that were considered non-modifiable (e.g. age) were entered into block 1, material variables considered modifiable (e.g. non compliant with medications) were entered into block 2, and knowledge technology variables were entered into block 3.

Selection and Availability of Chosen Variables

The variables were chosen based on an extensive literature review as detailed in Chapter Two. Table 5 compiles the variables identified from the literature review and whether the variables were available in the original data set. If the exact variable from the literature search was not available in the data set, a similar variable that was available in the data set may have been substituted.

Table 5

Chosen Variables: Placement in Verran's Framework

VF	Variables based on Literature Search	Available in Data Set	Chosen Variables
	Demographic		
MT	Age	Yes	Age
MT	African American and Hispanic races	Yes	Race
MT			Gender
MT	Poverty	Yes	Economic Status
MT	Urban residence	No	
MT	Large family size	No	
MT	Crowding	No	
MT	Smoking	Yes	Exposure to smoke
MT	Low birth weight	Yes	Prematurity
MT	Exposure to cockroaches	No	
	Pre-existing conditions		
MT	Annual influenza vaccine	Yes	Influenza in the past year
MT	History – Rhinitis/sinusitis	Yes	History – Rhinitis/sinusitis
MT	Viral respiratory infections	Yes	Upper respiratory infection
			Other respiratory condition
MT	Gastroesophageal reflux	No	
MT	Family history of asthma	Yes	Family history of asthma
MT	Family history of allergies	No	
MT	Psychological/psychosocial problems	No	
	Risk factors		
MT	Use of > 3 asthma medications to control symptoms	Yes	Steroid dependence
MT	Non adherence	Yes	Noncompliant with medications
MT	Previous life threatening exacerbation	Yes	History – intubation
MT	Previous ED/inpatient admissions in past 12 months	Yes	Asthma seen within 24 hours
MT			Asthma ED visit within 2 weeks
MT			Asthma admitted within 2 weeks
MT			Asthma admitted within 12 months
MT			Respiratory seen within 24 hours
MT			Respiratory ED visit within 2 weeks

Chosen Variables: Placement in Verran's Framework (continued)

VF	Variables Based on Literature Search	Available in Data Set	Chosen Variables
MT			Respiratory admitted within 2 weeks
MT			Respiratory admitted within 12 months
	Recommended Interventions		
KT	Systemic corticosteroid	Yes	Corticosteroid oral
KT			Corticosteroid intravenous/intramuscular
KT			Time first steroid administered
KT	Beta$_2$-agonists	Yes	Number of beta$_2$-agonists administered
KT			Time first beta$_2$-agonist administered
KT			Time second beta$_2$-agonist administered
KT	Anticholinergic	Yes	Anticholinergic
KT	Oxygen	No	

Note: VF=Verran's Framework (1997), MT=Material Technology, KT=Knowledge Technology

Statistical Analysis

The SPSS program was used to analyze the data for this study. Descriptive statistics were used to describe the sample and determine the variables that were chosen to be considered in the LR equation. Forward stepwise LR, using block entry of the variables, was used to answer each research question. Using this method, variables with the smallest significance level enter into the model first at each block. Removal criteria are based on the Wald statistic. The variable with the largest significance level for the

Wald statistic is removed from the model. The model is estimated without the deleted variable and the variables are again examined for removal. This process continues until either a previously considered model is encountered or no more variables are eligible for removal (Norusis, 1990).

The concept of OR is central to LR. Using ORs, the explanatory power of each statistically significant independent variable can be discussed using the concept of odds. Huck (2000) defines OR as a measure of the strength of association between each independent variable and the dependent variable (hospitalization). Since OR is a statistic and infers a population parameter, 95% CIs are reported for the variables.

CHAPTER FOUR

RESULTS

Chapter Four consists of a description of the sample and the results of the logistic

regression (LR) analysis used to answer the research questions. The significant materials

and knowledge technology variables for pediatric asthma patients experiencing a severe

asthma exacerbation were analyzed as they relate to the outcome of hospitalization when

structure is controlled.

Sample Description

Beginning with the complete database, subjects (n = 1,122) were coded for

asthma exacerbation severity. Those subjects meeting the criteria of severe asthma

exacerbation totaled 232. Data on these 232 subjects were used in the data analysis.

Henceforth, when referring to the sample, only the 232 subjects meeting the severe

exacerbation criteria will be included.

Descriptive statistics were generated to describe the sample. The mean age of the

subjects was 5.32 (SD = 4.1) years, with a range of 0-17. The sample consisted of 68%

males and 33% females. The races of the subjects were as follows: 42% (n=97) White,

33% (n=76) Black, 1% (n=2) Hispanic, 4% (n=10) Asian, and 3% (n=8) other; however,

data on race was unavailable for 17% (n = 39) of the sample. The sample contained 32%

subjects (n = 74) with the outcome of hospitalization. While an overwhelming majority of

the subjects who were hospitalized were admitted to the Military Treatment Facility

(MTF) where the Emergency Department (ED) care was provided, 8% were admitted to a

different MTF and 2% were admitted to a civilian medical facility.

Comparison of Group 1 and 2

Groups 1 (hospitalized) and 2 (not hospitalized) were compared using the chosen

variables listed in Table 5. Chi-square procedures (dichotomous variables) and t-tests

(continuous variables) were used to assess the differences between the two groups.

Statistically significant differences ($\alpha < .05$) were found for the following variables: age

(p = .012), exposure to smoke (p = .025), history of intubation (p = .002), admitted for

asthma within 2 weeks (p = .038), admitted for asthma within 1 year (p = .013),

corticosteroid administered intraveneously or intramuscularly (IV/IM) (p = .000),

anticholinergic administered (p = .002), number of beta$_2$-agonists administered

(p = .000), and time first beta$_2$-agonist was administered (p = .004). Those variables for

which a statistically significant difference was found were chosen to be considered in the

LR equation. Tables 6 (continuous variables) and 7 (dichotomous variables) list the

results of the comparison between groups, while maintaining Verran's framework (1997)

identification.

Table 6

T-Test Results Comparing Groups 1 (Hospitalized) and 2 (Non Hospitalized) on Chosen
Variables

VF	Variable	Grp 1 M (SD)	Grp 2 M (SD)	p
	Demographics			
MT	* Age	6.4 (4.7)	4.8 (3.8)	.012
	Recommended Interventions			
KT	Time first steroid administered	70.83 (65.8)	63.30 (51.4)	.598
KT	* Number of $beta_2$-agonists administered	3.58 (1.8)	2.51 (1.1)	.000
KT	* Time first $beta_2$-agonist administered	25.94 (21.5)	35.98 (27.2)	.004
KT	Time second $beta_2$-agonist administered	49.00 (35.6)	69.09 (137.0)	.135

Note: VF=Verran's Framework (1997), M = Mean, SD = Standard Deviation,
MT=Material Technology, KT=Knowledge Technology, p = Significance, * indicates
variables selected.

Table 7

Chi-Square Results Comparing Groups 1(Hospitalized) and 2 (Non Hospitalized) on Chosen Variables

VF	Variable	% Grp 1	% Grp 2	X^2	p
	Demographic				
MT	Race			3.803	.433
	White	47.1	52.0		
	Black	40.0	39.0		
	Hispanic	0	1.6		
	Asian	8.6	3.2		
	Other	4.3	4.1		
MT	Gender			.105	.746
	Male	66.2	68.4		
	Female	33.8	31.6		
MT	Economic Status (Sponsor Paygrade)			3.354	.187
	E1-E4	19.2	25.2		
	E5-E9	75.3	63.9		
	O1-O6, W1-W4	5.5	11.0		
MT	* Exposure to smoke	13.5	5.1	5.028	.025
MT	Prematurity				
	Pre-existing conditions				
MT	Influenza in the past year	4.1	1.3	1.858	.173
MT	History – Rhinitis/sinusitis	1.4	1.9	.000	.984
MT	Upper Respiratory Infection	0	0	-	-
MT	Other respiratory condition	1.4	4.4	1.435	.231
MT	Family history of asthma	17.6	13.3	.737	.391
	Risk factors				
MT	Steroid dependence	0	0	-	-
MT	Noncompliant with medications	2.7	4.4	.403	.525
MT	* History – intubation	8.1	.6	9.624	.002
MT	Asthma seen within 24 hours	6.8	3.8	.977	.323
MT	Asthma ED visit within 2 weeks	1.4	3.2	.658	.417
MT	* Asthma admitted within 2 weeks	2.7	0	4.307	.038
MT	* Asthma admitted within 12 months	17.6	7.0	6.112	.013
MT	Respiratory seen within 24 hours	1.4	0	2.144	.143

Chi-Square Results Comparing Groups 1 and 2 on Chosen Variables (continued)

VF	Variable	% Grp 1	% Grp 2	X^2	p
MT	Respiratory ED visit within 2 weeks	0	.6	.470	.493
MT	Respiratory admitted within 2 weeks	1.4	0	2.144	.143
MT	Respiratory admitted within 12 months	1.4	1.9	.089	.765
	Recommended Interventions				
KT	Corticosteroid oral	56.8	63.3	.906	.341
KT	* Corticosteroid intravenous/intramuscular	32.4	10.8	16.270	.000
KT	* Anticholinergic	39.2	19.6	10.065	.002

Note: VF=Verran's Framework (1997), MT=Material Technology, KT=Knowledge Technology, X^2 = Chi-square, p = Significance, * indicates variables selected.

Logistic Regression

The following section describes the LR procedures, the variables that were significant enough to remain in the equation, and the end results of the LR.

Variable Entry

The independent variables that were found to be statistically significant in the analysis of difference procedures were placed in 3 categories: (block 1) non-modifiable materials technology, (block 2) modifiable materials technology and (block 3) knowledge technology. Table 8 lists these variables according to category and entry block. The variables were entered using block format into a forward stepwise LR equation. Group 1 (hospitalized) with 74 subjects and Group 2 (not hospitalized) with 158 subjects were

used in the LR equation. Twenty-two cases with missing data were eliminated from the analysis.

In block 1, age, history of intubation, and asthma admission within 1 year entered into the LR equation but history of intubation and asthma admission within 2 weeks did not. Upon adding block 2 variables, age, history of intubation, and asthma admission within 1 year remained in the equation; however, exposure to smoke did not enter into the equation. At the completion of the LR (block 3), age, history of intubation, and asthma admission within 1 year remained in the equation, while number of $beta_2$-agonists administered and corticosteroid IV/IM administered also entered into the equation. Anticholinergic administered and time first $beta_2$-agonist administered did not enter the equation.

Table 8

Variables of the Logistic Regression Equation Identified by Block Entry

Non-Modifiable MT Block 1	Modifiable MT Block 2	Knowledge Technology Block 3
• **Age** • **History – intubation** • Asthma admitted within 2 weeks • **Asthma admitted within 1 year**	• Exposure to smoke	• **Corticosteroid IV/IM** • Anticholinergic • **Number of $beta_2$-agonists administered** • Time first $beta_2$-agonist administered

Note: MT=Materials Technology, **bold** indicates those variables that entered into the LR equation.

Final Results

The results of the LR analysis are listed in Table 9, to including level of significance and odds ratios and the lower and upper limits of the odds ratio (OR) at a 95 percent confidence interval (CI) for those variables that entered into the LR equation. Using an a prior alpha at the .05 level, four of the five variables were statistically significant. Those variables found to be significant were history of intubation (p = .029), admitted with asthma within 1 year (p = .016), corticosteroid IV/IM administered (p = .001), and number of beta$_2$-agonists administered (p = .000). Age was not statistically significant.

Table 9

Results of Enter Method Logistic Regression Analysis Using Block Entry for Variables

Block/ VF	Variable	p	OR	Lower	Upper
				95% CI for OR	
1					
MT	Age	.022	1.087	1.012	1.167
MT	History – intubation	.056	.116	.013	1.060
MT	Asthma admitted within 1 year	.017	.338	.139	.823
2	Nothing Entered				
3					
MT	Age	.394	1.036	.955	1.123
MT	History – intubation	.029	.066	.006	.761
MT	Asthma admitted within 1 year	.016	.307	.118	.803
KT	Corticosteroid IV/IM	.001	.238	.106	.535
KT	Number of beta$_2$-agonists administered	.000	1.832	1.377	2.438

Note: VF=Verran's Framework (1997), p = Significance, OR = Odds Ratio, CI = Confidence Interval, MT=Material Technology, KT=Knowledge Technology.

Based on the ORs for the statistically significant variables, the following was concluded: (1) those subjects with a history of intubation were one fifteenth as likely to be hospitalized than those who did not have a history of intubation, (2) subjects who had been admitted within 1 year were one third as likely to be hospitalized than those who had not been admitted within the year, (3) those subjects who had received a corticosteroid IV/IM in the ED were one fourth as likely to be hospitalized than those subjects who did not receive a corticosteroid IV/IM, and (4) hospitalization is 1.83 times more likely as the number of beta$_2$-agonists administered increases approximately by one (See Table 6).

The model predicted hospitalization as an outcome at a rate of 42 percent and discharge as an outcome at a rate of 89 percent. The model's overall prediction rate was 74 percent. The results of a Hosmer and Lemeshow goodness-of-fit procedure [model X^2 (7) = 12.602, p = .082] indicated that the data was a good fit for the model, that it did not differ significantly from the best fit model.

Summary

Between Group 1 (hospitalized) and Group 2 (non hospitalized), statistically significant differences (alpa < .05) were found for the following nine variables: age, exposure to smoke, history of intubation, admitted for asthma within 2 weeks, admitted for asthma within 1 year, corticosteroid administered IV/IM, anticholinergic administered, number of beta2-agonists administered, and time first beta2-agonist was administered. Using block format, these variables were entered into the forward stepwise LR equation. At the completion of the LR, age, history of intubation, asthma admission

within 1 year, number of beta2-agonists administered, and corticosteroid IV/IM remained

in the equation. History of intubation, asthma admission within 1 year, number of beta2-

agonists administered, and corticosteroid IV/IM were statistically significant.

CHAPTER FIVE

DISCUSSION

The purpose of this study was to determine the most significant materials and knowledge technology variables as they relate to the outcome of hospitalization of pediatric patients experiencing severe asthma exacerbations, while controlling the structural context. The discussion of the results, limitations of the study, recommendations for further research, and implications for nursing are presented in this chapter.

The original data were collected from major Military Treatment Facility (MTF) Emergency Departments (EDs). These settings were tertiary facilities, which provide aggressive care and are more likely to deal with emergency events better than secondary or primary facilities. The subjects selected for this study were all classified as having severe asthma exacerbations. Using the National Heart, Lung, and Blood Institute (NHLBI) asthma severity classification guideline, only the most severe cases were selected based on clinical signs. The specificity of both the setting and sample selection might have contributed to the unique findings of this study.

In beginning the discussion, it is important to note the differences between groups using the variables that were found to be statistically significant through t-tests and chi-square procedures. Group 1 (hospitalized) had a higher mean age (6.4 years) than the comparison group (4.8 years). The number of beta$_2$-agonists administered to Group 1 was 3.6, while Group 2 was administered an average of 2.5 beta$_2$-agonists. The average time

that the first beta$_2$-agonist was administered was 26 minutes for Group 1 and 36 minutes for Group 2. A total of 8% of Group 1 and 1% of the comparison group had a history of intubation. Almost 3% of Group 1 was admitted for asthma within two weeks compared to none of Group 2 and almost 18% of Group 1 was admitted within one year compared to 7% of Group 2. In Group 1, 32% received a corticosteroid intravenously (IV) or intramuscularly (IM) and 39% received an anticholinergic compared to 11% and 20% of Group 2 respectively. The importance of these data will be evident in later discussions.

Results in Relationship to the Literature Review

Question 1: Materials Technology Variables

The literature review was initially used to guide variable selection for the category of materials technology. Twenty-three variables were selected from the database based on the literature review. The materials technology variables represented the nature of the client with whom the nurse deals (Verran, 1997).

Based on the results of the analysis of differences tests (t-test and Chi-square) at the .05 level of significance, five materials technology variables were selected to be considered in the Logistic Regression (LR). The five variables that were added into Blocks 1 (modifiable variables) and 2 (non-modifiable variables) in the LR included age, history of intubation, asthma admitted within 2 weeks, asthma admitted within 1 year, and exposure to smoke. Of these five variables, two non-modifiable variables, history of intubation and asthma admitted within 1 year remained statistically significant at the end of the model.

Statistically Significant Materials Technology Variables

The results demonstrated that those subjects with a history of intubation were one

fifteenth as likely to be hospitalized than those without a history of intubation (OR =

.066, 95% CI = .006-.761). Those subjects having been admitted for asthma within 1 year

were one-third as likely to be hospitalized (OR = .307, 95% CI = .118-.803) as those

subjects not having been admitted for asthma within the year. While these findings are

inconsistent with the literature, the results are significant.

Prior asthma hospitalization and history of intubation are well known asthmatic

risk factors associated with increased chance of hospitalization (Brenner & Kohn, 1998;

Sly & O'Donnell, 1997). Smith and Strunk (1999) report that children with a history of

intubation, past ED visits, or prior hospitalizations for asthma should alert clinicians that

these children may have more severe asthma or poor control and therefore, require close

observation and aggressive treatment. This may be one explanation for the findings in

this study. With the increased awareness of the NHLBI guidelines, clinicians may be

treating those patients with severe asthma more aggressively, ultimately leading to better

outcomes (i.e. fewer hospitalizations). It is possible that those patients with known risk

factors for increased chance of hospitalization, such as history of intubation and prior

asthma admission within one year, are being treated aggressively, resulting in recovery

and discharge home.

Evidence that the sample in this study was treated aggressively includes the fact

that both groups were treated quickly and received multiple beta$_2$-agonists. However, the

symptoms of Group 1 subjects were probably more clinically severe, as evident by the

fact that this group was administered the first and second beta$_2$-agonists quicker and received more beta$_2$-agonists than the comparison group.

Question Number 2: Knowledge Technology Variables

The literature review was also used to guide variable selection for the category of knowledge technology. Seven variables were selected from the database based on the literature review. These variables represented the intensity of care provided to a subject. Based on the results of the analysis of differences tests (t-test and Chi-square), four knowledge technology variables were selected to be considered in the LR. The four variables that were added into Block 3 in the LR included corticosteroid intravenous/intramuscular (IV/IM), anticholinergic, number of beta$_2$-agonists administered, and time first beta$_2$-agonists administered. Of these four variables, corticosteroid IV/IM and number of beta$_2$-agonists administered were statistically significant in the logistic equation analysis.

Statistically Significant Knowledge Technology Variables

Those subjects who had received a corticosteroid IV/IM in the ED were one fourth as likely to be hospitalized than those subjects who did not receive a corticosteroid IV/IM (OR=.238, 95% CI = .106-.535). It was also found that hospitalization is 1.83 times more likely as the number of beta$_2$-agonists administered increases by one for pediatric asthma patients experiencing a severe exacerbation seen in the ED (OR=1.832, 95% CI = 1.377-2.438). In other words, an increase in the number of beta$_2$-agonists administered would result in a higher prediction of hospitalization. While the literature supports this result, the finding that subjects who had received a corticosteroid IV/IM in

the ED were less likely to be hospitalized than those subjects who did not receive a corticosteroid IV/IM is not supported by the literature.

According to the NHLBI guidelines, patients who are assessed as having a severe asthma exacerbation in the ED should receive an inhaled high-dose beta$_2$-agonist and an anticholinergic every 20 minutes or continuously for one hour. The patient should also receive an oral corticosteroid. If the patient shows no improvement after the initial treatment, an inhaled short acting beta$_2$-agonist should be administered hourly or continuously. Also, an inhaled anticholinergic and an oral systemic corticosteroid should be administered. It is not until the third phase of the NHLBI treatment guideline that the patient is to receive a corticosteroid either IV or IM. If the decision is made to discharge the patient home, the oral course of corticosteroids should be continued. If the decision is made to hospitalize the patient, a corticosteroid should be administered IV or IM (NAEPP, 1997). From the NHLBI guidelines, one can conclude that the more severe the asthma exacerbation, the higher the number of beta$_2$-agonists, anticholinergics, and corticosteroids would be administered. Additionally, only those patients that were to be hospitalized would receive a corticosteroid IV or IM.

The results in this study demonstrate that the NHLBI guidelines were not followed exactly. None of the subjects in Group 2 should have received a corticosteroid IV/IM according to the guideline, yet 10.8% of the subjects did. However, key variables that may have contributed to this are unknown. For example, the corticosteroid may have been administered to the subjects based on such factors as clinician instinct. Also, it is interesting to note that the time of first corticosteroid administration was earlier for

Group 2 than Group 1. This supports the hypothesis that it may actually be the

aggressiveness of treatment that led to subjects' discharge; however, further research is

needed to test this hypothesis.

Variables Not Found Significant

Two materials technology variables, asthma admitted within 2 weeks, and

exposure to smoke, and two knowledge technology variables, anticholinergic

administration and time first beta$_2$-agonist was administered, were found to have

significant differences between groups but did not enter the LR equation. In LR, it is the

combination of the variables that is used to form the prediction model. These four

variables did not add to the predictive capability of the total model and thus, did not enter

the model. Age entered into the LR but was not found to be statistically significant at the

end of the analysis.

One reason why asthma admitted within 2 weeks did not enter the model but

asthma admitted within 1 year did may be due to the fact that there were only 2 subjects

(both in Group 1) of 232 that had been admitted for asthma within 2 weeks. The rare

nature of the variable and not its relevance may be the reason it did not enter the

equation. Exposure to smoke was not specifically defined in the original database and

therefore it is unknown how much exposure to smoke each subject had (e.g. a one time

exposure versus being exposed by a family member every day). Because of this, it is

difficult to explain why exposure to smoke did not enter the equation. The group that was

hospitalized had twice as many subjects who were administered anticholinergics than the

comparison group. While this appears significant, the time at which the anticholinergics

were administered was not available. It is possible that this factor might have helped explain why this variable was not found significant. The group that was hospitalized were administered their fist beta$_2$-agonist an average of 10 minutes faster than the comparison group. While this difference was found to be statistically significant between groups, the time difference may not be clinically significant.

Results in Relationship to the Conceptual Framework

Verran's Theory Driven Framework (1997) was used to guide this study. The framework was useful for this pediatric management outcome study because it takes into account the interrelationships among materials and knowledge technology variables, structural variables, and outcomes. This interrelationship is an important aspect as illustrated by the fact that both materials and knowledge technology variables were found to be significant to hospitalization as an outcome with pediatric patients experiencing a severe asthma exacerbation, while controlling the structural context.

Using Verran's framework to select and control for variables, the framework's overall predictive capability for hospitalization as an outcome was 74%. While the model predicted those not hospitalized at a rate of 89%, the prediction rate for hospitalization as an outcome was only 42%. There are several factors that might have increased the predictive quality of the framework used for this study. First, there were a number of variables identified by the framework and literature review but were unavailable in the original data set. Perhaps by adding the additional variables, the frameworks ability to predict would have improved. Also, current knowledge is limited about which factors best predict hospitalization from the ED. Furthermore, the decision to hospitalize a child

with asthma cannot be based on objective data alone, but also includes such factors as medical facility standards, cost of care, clinician instinct, geographic issues, psycho/social issues, and lack of appropriate follow-up, which were not available in the data set.

<div align="center">Limitations of the Study</div>

This study was limited by the following factors:

1. The structural variable was limited to Department of Defense (DoD) pediatric asthma subjects being treated in a major MTF ED, thus limiting the generalizability of the results to that population.

2. The unavailability of potentially key variables (e.g. peak expiratory flow rate, geographic location, psychological/psychosocial history) limits the completeness of the risk factor list.

3. The physical signs and symptoms of the subjects were not used as variables because they were used to control and select the "severe" subjects to be used in this study, which limits these variables as potential predictors of hospitalization as an outcome.

4. This was a secondary analysis and the specifics of data collection procedures were beyond the control of this researcher; thus, the data may have inaccuracies that are not known.

Recommendations for Further Research

Specifically Examine Severe Cases Using Other Databases

The present study examined pediatric asthma subjects classified as having a severe exacerbation. Future research, focusing specifically on severe asthma exacerbation cases, should be conducted to validate the findings of this investigation. Such a study might possibly reveal more key factors associated with hospitalization of children with severe asthma exacerbations.

Choose Different Materials and Knowledge Technology Variables

Future research should include a prospective study of asthmatic patients experiencing a severe exacerbation in the ED, allowing for input of other variables beyond those in this study that might provide predictors for hospitalization as an outcome. While the variables found to be significant in this study predicted discharge better than hospitalization, other variables better predict hospitalization as an outcome. Future research needs to be conducted to determine what those variables are.

Study Geographic Variations

Geographic location was not available for this study. The literature suggests that certain geographic areas increase the risk of hospitalization for pediatric asthma patients (Carr, et al., 1992; Weiss, 1990; Wennberg, et al., 1984). If geographic area were found to be a significant variable in regards to hospitalization as an outcome, it might benefit the DoD to place military personnel and family members of military personnel with asthma in geographic locations that have been found to have reduced asthma hospitalization and mortality rates.

Nursing Implications

Asthma treatment in the ED involves the difficult decision as to whether to discharge the patient, continue treatment, or hospitalize the patient. The concept of determining the need for hospitalization early in the course of ED treatment is appealing because this may decrease cost and time of care in the ED. However, currently there are no definitive guidelines or methods to accurately predict hospitalizations (Brenner & Kohn, 1998; Schuh, et al., 1997; Smith & Strunk, 1999). The literature is filled with controversy regarding which factors best predict hospitalization from the ED. Additionally, few studies dealing with predictors of hospitalization have been conducted with children (Schuh, et al., 1997). The decision to hospitalize a child with asthma cannot be based on objective data alone but also includes such factors as medical facility standards, cost of care, geographic issues, psycho/social issues, and lack of appropriate follow-up.

Nurses need to play an active role in outcome research. Nurses have a broad understanding of both the technology and structural processes that influence outcomes. Non-clinical research analysts may not have a full understanding of how variables specifically influence the outcome, which restricts the interpretation of the results.

While some of the findings in this study at face value appear to be inconsistent with the literature, it is evident why these types of outcome studies are important and must be conducted. In the past, it has been found that risk factors such as history of intubation and being admitted for asthma within one year meant an increased chance of hospitalization. The results of this study suggest that aggressive treatment to pediatric

asthma patients experiencing a severe exacerbation with known risk factors for increased chance of hospitalization actually increased their chance of being discharged from the ED. Since nurses are often the first to screen, assess severity level, and initiate treatment of asthmatic patients, they can immediately alert clinicians to patients with these risk factors so that aggressive treatment can be initiated as rapidly as possible.

Data are needed that support the achievement of beneficial outcomes. Understanding what variables are involved in managing asthma and what outcomes are anticipated is imperative. It is essential that research in this area continues and nurses are key players to make this happen.

Summary

The results of this study found two significant materials technology variables, history of intubation and admission for asthma within one year, and two significant knowledge technology variables, corticosteroid IV/IM administered and number of beta$_2$-agonists administered. Because of the limitations of the study, these variables are not all inclusive. The results demonstrate the uniqueness of this study in examining specifically asthmatic subjects experiencing specifically a severe exacerbation. All variables except number of beta$_2$-agonists administered showed results inverse to what the literature suggests.

History of intubation and admission for asthma within one year are well known asthmatic risk factors for increased hospitalization, yet the results of this study demonstrate that it is possible that with identification of patients with these risk factors and extremely aggressive treatment, the outcome might be discharge and not

hospitalization. Furthermore, more aggressive corticosteroids IV/IM treatment (earlier administration) with than the NHLBI guideline suggests might also lead to an improved outcome (discharge) for pediatric asthma patients experiencing a severe exacerbation.

Nurses are of the utmost importance to outcomes research as they possess the expertise in both the technology and structural processes and how the variables influence the outcome, which facilitates the interpretation of the results. Outcomes studies such as this are essential in today's health care. Monitoring outcomes associated with asthma guideline use and using the results to support or possibly adjust the guideline are important issues associated with asthma medical care and guideline success.

APPENDIX A

LETTER OF EXEMPTION FROM HUMAN SUBJECTS REVIEW

THE UNIVERSITY OF
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9 November 2000

Debora J. Marston, B.S.N.
Advisor: Paula Meek, Ph.D.
College of Nursing
PO BOX 210203

RE: PEDIATRIC ASTHMA EXACERBATIONS SEEN IN THE EMERGENCY
      DEPARTMENT: A DESCRIPTIVE STUDY OF FACTORS THAT INFLUENCE
      HOSPITALIZATION AS AN OUTCOME

Dear Ms. Marston:

We received documents concerning your above cited project. This project involves the retrospective review of medical records (database to be provided by Lieutenant Colonel Williamson, Population Health for Clinical Quality, Deputy Operations Director, Department of Defense without identifiers). Therefore, regulations published by the U.S. Department of Health and Human Services [45 CFR Part 46.101(b) (4)] exempt this type of research from review by our Committee.

Thank you for informing us of your work. If you have any questions concerning the above, please contact this office.

Sincerely,

David G. Johnson, M.D.
Chairman
Human Subjects Committee

DGJ/js
cc: Departmental/College Review Committee

APPENDIX B

AGENCY APPROVAL FOR SECONDARY DATA ANALYSIS

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
HEALTH AFFAIRS
SKYLINE FIVE, SUITE 810, 5111 LEESBURG PIKE
FALLS CHURCH, VIRGINIA 22041-3206

TRICARE
MANAGEMENT
ACTIVITY

Captain Debora J. Marston
6726 West Nueva Vista Drive
Tucson, AZ 85743-1016

Dear Captain Marston:

You have requested to do a data analysis on a data set commissioned by the Department of Defense. You have identified yourself as an Active Duty Air Force officer on official orders to complete your Masters in Nursing at the University of Arizona, Tucson, Arizona. You have also identified that the University of Arizona College of Nursing mandates a thesis as a degree requirement. It is my understanding that your purpose for this secondary analysis is to develop a thesis based on pediatric asthma specific to the population of Department of Defense health care beneficiaries.

The 1997 compilation of data and report of the analysis titled Pediatric Asthma Quality Management Review by the FMAS Corporation were commissioned to discover within TRICARE "best practices" and to communicate the findings. "Best practices" are defined as those practices that result in superior patient outcomes with the most efficient use of resources.

You are authorized to use the 1997 data with the following stipulations. First, any publication of your findings will require pre-authorization from us. The Joint Ethics Regulation, DoD 5500-7R, paragraph 3-307b, says writing that pertains to military matters, national security issues, or subjects of significant concern to DoD shall be reviewed for clearance by appropriate security and public affairs offices prior to publication. Second, identifying information regarding specific medical institutions or individuals will not be published in either your original thesis manuscript or any future publications.

Please forward a signed response indicating your agreement to abide by our data use requirements. I look forward to reviewing your work. If I can be of further assistance, please feel free to contact me.

Sincerely,

James F. Williamson, LtCol, USAF, BSC
Deputy Operations Director, Population
Health for Clinical Quality

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